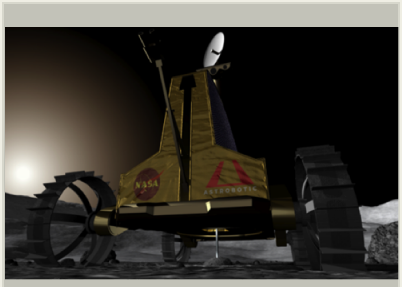
Resource-Aware Planning for Shadowed and Uncertain Domains, Phase I

Completed Technology Project (2013 - 2013)

Project Introduction

Discovery of frozen volatiles at the lunar poles is transformative to space exploration. In-situ resources will provide fuel to support far-reaching exploration and enable commercial endeavors. While satellite data supports presence of polar ice, driving and drilling must confirm presence, determine composition, and measure distribution. Ice exists primarily in the dark and cold of polar craters. Current planetary rover planning technologies are not designed for these environments and have avoided them altogether, operating only in mid-latitudes. The proposed research innovates an Earth-based, resource-aware path planner for a polar prospecting rover. The proposed planner models progress toward the goal while considering resource costs inherent in that progress, generates and explores the space of possible paths, then transmits a set of low-cost viable paths to goal to the rover. The set of viable paths then resides on the rover to inform limited re-planning if the rover encounters a hazard during traverse, even during communications dropout. The planner considers all of the impacts on polar rover operation – light angles that change over time, thermal operating window, sun angles and blinding light, and communications-shadowed regions. Each of these impacts affects one of the rover's resources – where it can go, what it can see, how cold it can get, how much battery charge remains, and whether it can communicate with its operator. Design of the proposed planner will build on pioneering research at Carnegie Mellon that developed TEMPEST, a temporal-aware, mission-based planner that maximized battery power over a traverse. It was demonstrated using the Hyperion rover, achieving a sun-synchronous traverse of Haughton Crater. The polar environment is both adversarial and unpredictable, and the proposed planner will extend the TEMPEST to account for the unique challenges of navigating on the poles of planetary bodies and add nondeterministic planning.



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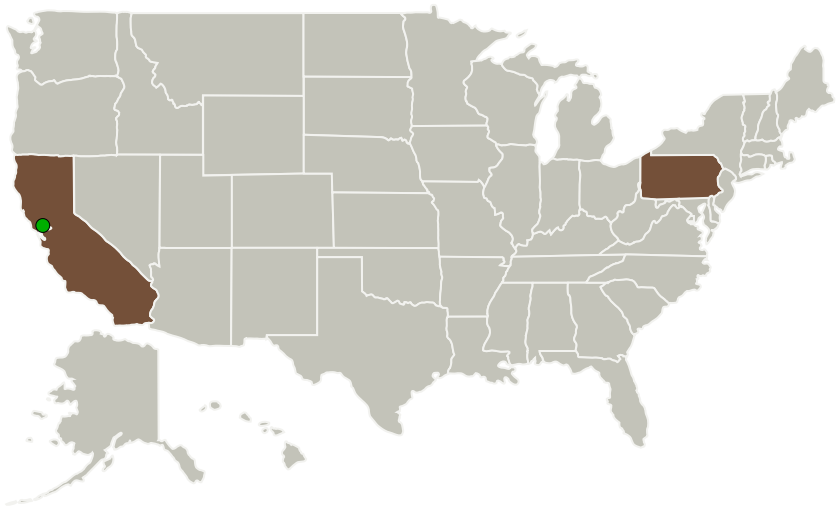
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Astrobotic Technology, Inc.	Lead Organization	Industry	Pittsburgh, Pennsylvania
Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations	
California	Pennsylvania

Project Transitions

May 2013: Project Start

November 2013: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/140706)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Astrobotic Technology, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

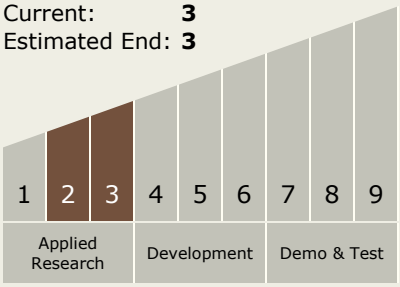
Carlos Torrez

Principal Investigator:

Kevin Peterson

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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Images

Project Image
Resource-Aware Planning for Shadowed and Uncertain Domains
(https://techport.nasa.gov/image/132568)

Technology Areas

Primary:

- TX10 Autonomous Systems
  - TX10.2 Reasoning and Acting
    - TX10.2.4 Execution and Control

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System